

# Zero-Shot Image Restoration Using Denoising Diffusion Null-Space Model

Year: 2022 | Citations: 580 | Authors: Yinhuai Wang, Jiwen Yu, Jian Zhang

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## Abstract

Most existing Image Restoration (IR) models are task-specific, which can not be generalized to different degradation operators. In this work, we propose the Denoising Diffusion Null-Space Model (DDNM), a novel zero-shot framework for arbitrary linear IR problems, including but not limited to image super-resolution, colorization, inpainting, compressed sensing, and deblurring. DDNM only needs a pre-trained off-the-shelf diffusion model as the generative prior, without any extra training or network modifications. By refining only the null-space contents during the reverse diffusion process, we can yield diverse results satisfying both data consistency and realness. We further propose an enhanced and robust version, dubbed DDNM+, to support noisy restoration and improve restoration quality for hard tasks. Our experiments on several IR tasks reveal that DDNM outperforms other state-of-the-art zero-shot IR methods. We also demonstrate that DDNM+ can solve complex real-world applications, e.g., old photo restoration.